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The Seed: Urban Vertical Farming Germinated

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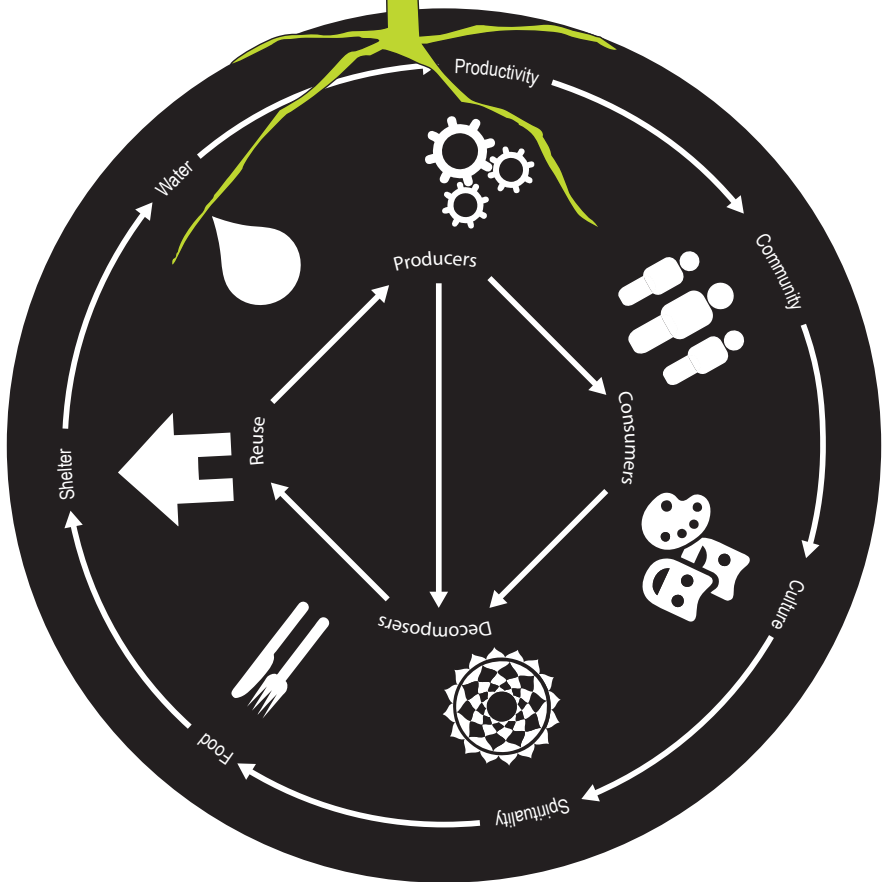
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THE SEED: Urban Vertical Farming Germinated



A city works as an ecosystem in many ways. However, we currently do not live within that ecosystem, as the difference between an ecosystem and a city is the waste output and food input . Nature and society do not exist independently because there are no spaces of nature unaffected by man. With this in mind we need to reestablish our relationship with nature. Architecture and engineering can be used to create buildings that will allow humans to turn cities into ecosystems. This thesis argues that Urban Vertical Farms will produce social and economic hubs that will be a new way to feed ever-increasing populations.

The industrial food system has done many great things for people including freeing up time for other activities. However, it has also changed the way people see food and the important place that it holds in the forming of culture. The mechanization of food has given many people jobs and supported lifestyles people previously could not sustain, but at what cost? With government provision and sustainable growing strategies many buildings could support their local area in an immediate way through the production of food both with fruits and vegetables as well as meats of different types.

This thesis is proposing a mixed use commercial and agricultural building within the Warehouse District of Minneapolis, Minnesota. With a population rise of 1100% in the last ten years and close proximity to areas in need of food justice action this building investigates the ability for buildings to act not only as shelter for people, but also as life springs for those living within its proximity. Food production, water filtration and education of the human connection to their role in nature are three of the tenants that “The Seed” addresses. The Seed will germinate the concept of Vertical Urban Farming as a strategy for implementation of food justice and security programs.

1. “Realtor.com.” Accessed October 22, 2015.

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“No ecosystem can exceed the limits of biomass production, which is strictly regulated by the total amount of incoming energy.. Cities do not follow this simple rule of nature, and therein lies the problem.”

The Vertical Farm - Dr. Dickson Despommier

“Community food security is rooted disciplinary in urban planning and community development rather than in agricultural of nutritional sciences.”

Together at the Table - Patricia Allen

Chapter 1 | Introduction

Definitions

SEED

/sĒD/

AN ORGANISM'S UNIT OF REPRODUCTION,
CAPABLE OF DEVELOPING INTO ANOTHER
SUCH ORGANISM.

EC • O • SYS • TEM

/ĒKŌ,sISTəM/

A BIOLOGICAL COMMUNITY OF INTERACTING
ORGANISMS AND THEIR PHYSICAL
ENVIRONMENT, LIVING IN BALANCE WITHOUT
WASTE.

AER • O • PON • ICS

/,E(ə)RŌ'PÄNIKS/

A PLANT-CULTIVATION TECHNIQUE IN WHICH THE ROOTS HANG SUSPENDED IN THE AIR WHILE NUTRIENT SOLUTION IS DELIVERED TO THEM IN THE FORM OF A FINE MIST.

HY • DRO • PON • ICS

/,HĪDRƏ'PÄNIKS/

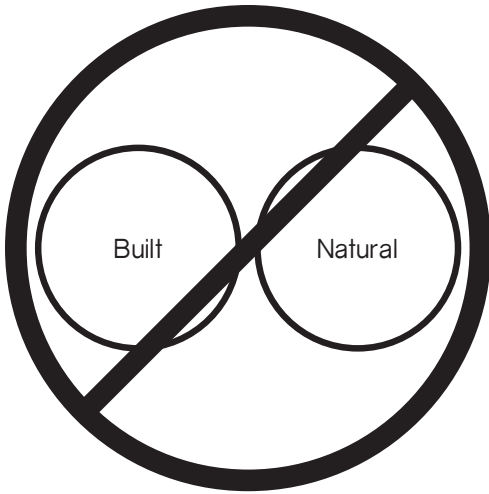
THE PROCESS OF GROWING PLANTS IN SAND, GRAVEL, OR LIQUID, WITH ADDED NUTRIENTS BUT WITHOUT SOIL.

AQ • UA • PON • ICS

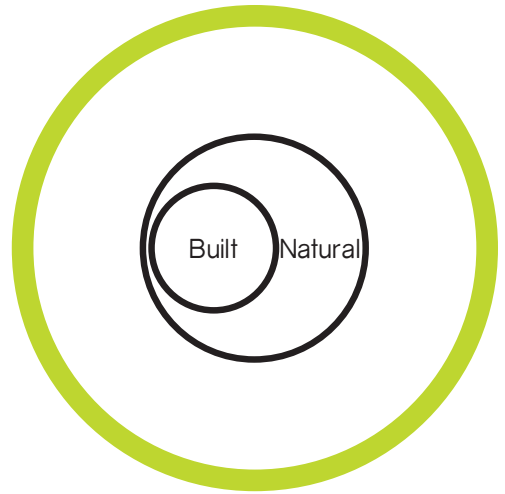
/,ÄKWƏ'PÄNIKS, AK-/

A SYSTEM OF AQUACULTURE IN WHICH THE WASTE PRODUCED BY FARMED FISH OR OTHER AQUATIC ANIMALS SUPPLIES NUTRIENTS FOR PLANTS GROWN HYDROPONICALLY, WHICH IN TURN PURIFIES THE WATER.

Perception of Environments



Actual Environments

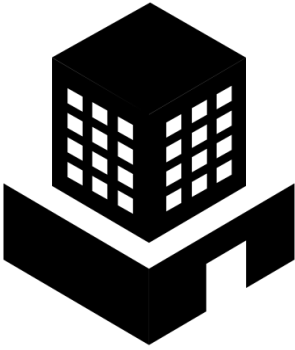


Every action in a city effects the environment, there is no distinct line dividing the built and natural environments

Claim | Contention

A city works as an **ecosystem** in many ways. However, we currently do not live within that ecosystem. The difference between an ecosystem and a city is the **waste output** and **food input**.

We need to **reestablish our relationship with nature**. Architecture and engineering can be used to create buildings that will allow humans to turn cities into ecosystems. This thesis argues that Urban Vertical Farms will produce **social and economic hubs** that will be a new way to feed ever-increasing populations.



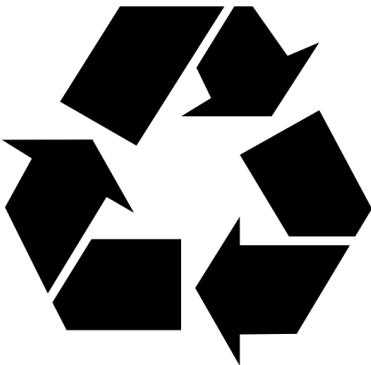
ABIOTIC COMPONENTS - ENVIRONMENT



PRODUCERS AT THE BASE - FOOD



CONSUMERS IN THE CHAIN - PEOPLE

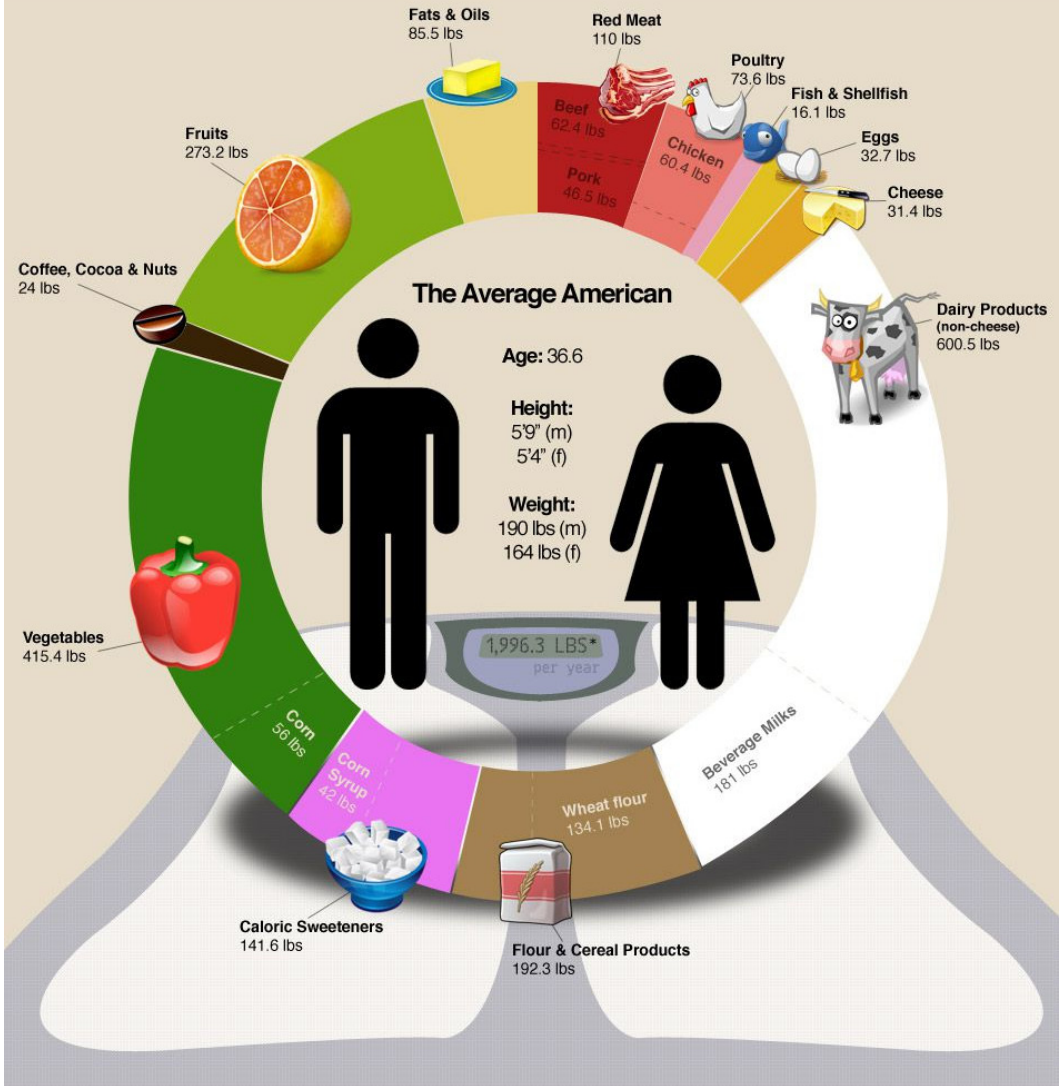


DECOMPOSERS AND NUTRIENT CYCLING -
WASTE TREATMENT

Components of an Ecosystem

As the city exists we use the input from farms and we export waste. Within Andrea Becker's definition of an ecosystem we currently only fulfil two of the four components of an ecosystem. We partially fulfil the component of waste treatment but the issue of food production at a more localized scale is just coming into the foreground with farmers markets, CSA (community-supported agriculture) shares and food co-ops. This ignores the immense industrial agri-food system, Vertical Urban Farming can start to change the way we see food.

What the Average American Consumes in a Year



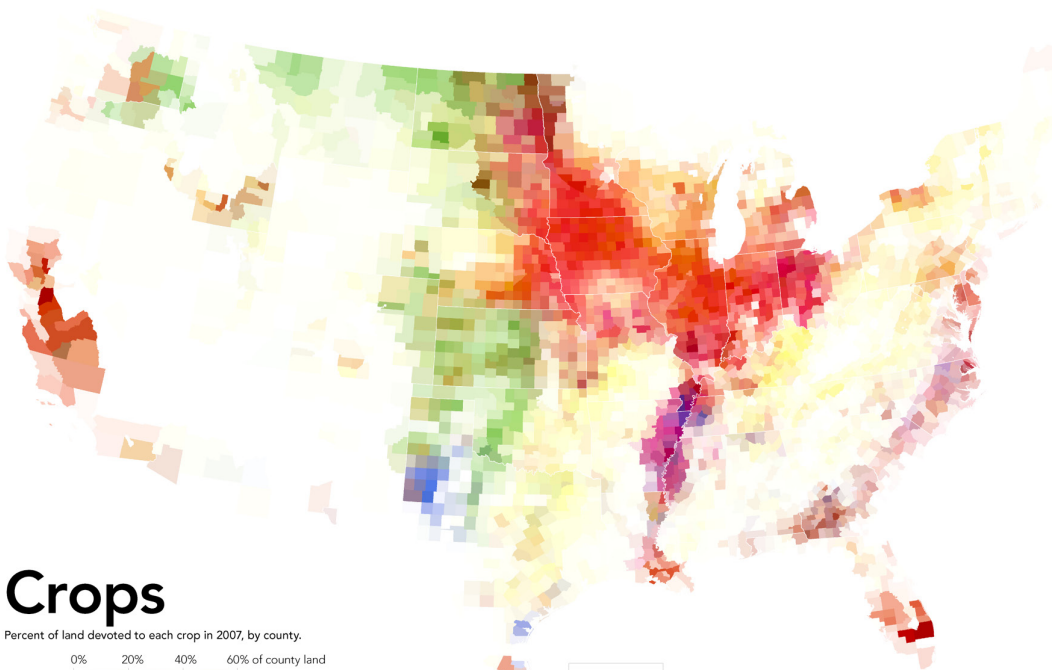
*includes food bought/served but not eaten (leftovers)

SOURCES:

<http://www.fda.gov>
<http://www.usda.gov/factbook/chapter2.htm>
<http://www.cdc.gov/nchs/data/nhsr/nhsr010.pdf>

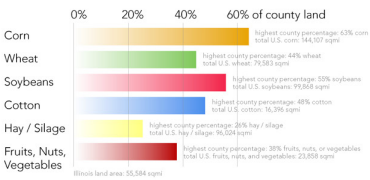
What We Eat

The United States is 16th in the world as far as daily consumption and 5th in meat consumption (FOASTAT). Vegetables constitute 20.8% of an average American's Diet. Dairy constitutes 31.7% of that diet. This can be seen as problematic. Pushed by large agro-food companies, in 2005 federal dietary guidelines advised adults to consume approximately three cups of milk per day, a full cup more than was previously recommended. Recent studies suggest adults need very little calcium and that consuming too much dairy can actually be harmful. Another question is whether we should be able to access any type of food any time, this question ties into much larger social questions which The Seed eliminates because the impact of seasonal foods does not effect a farm like The Seed.



Crops

Percent of land devoted to each crop in 2007, by county.



All maps shown at the same scale using equal-area projections. Data from the 2007 U.S. Census of Agriculture. Map by Bill Rankin, 2009.



Cropland in the United States is a majority corn, wheat, and soy. The Midwest is particularly stuck in these modes of farming. In Minnesota alone 35% of the crop is corn making up 50% of the total agriculture sales in Minnesota and soy makes up another 30% of sales (60% of this soy is exported to China). Less than 5% of the agriculture in Minnesota is other food productions. This is similar to cases around the nation. How can this change to create sustainable and just food systems within the United States?

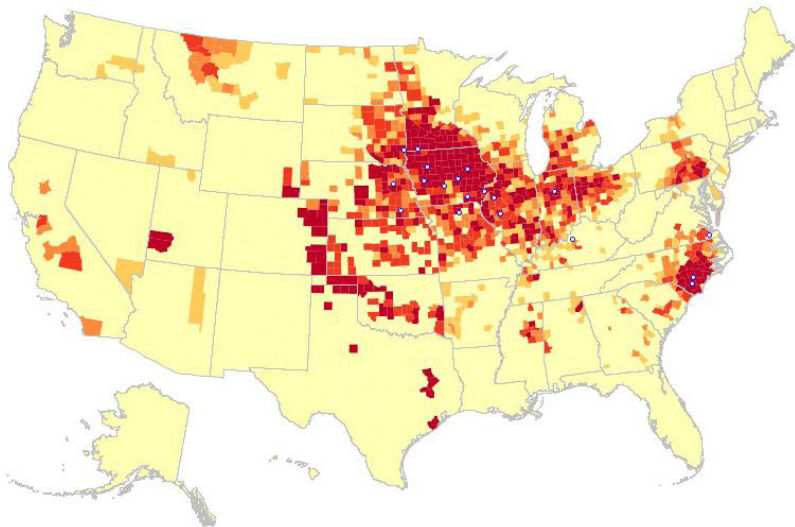
Filters

Animals Shown

- ☐ All
- ☐ Cattle
- ☐ Dairy
- ☒ Hogs
- ☐ Broilers
- ☐ Layers

Census Year

- 1997
- 2002
- 2007
- ☒ 2012



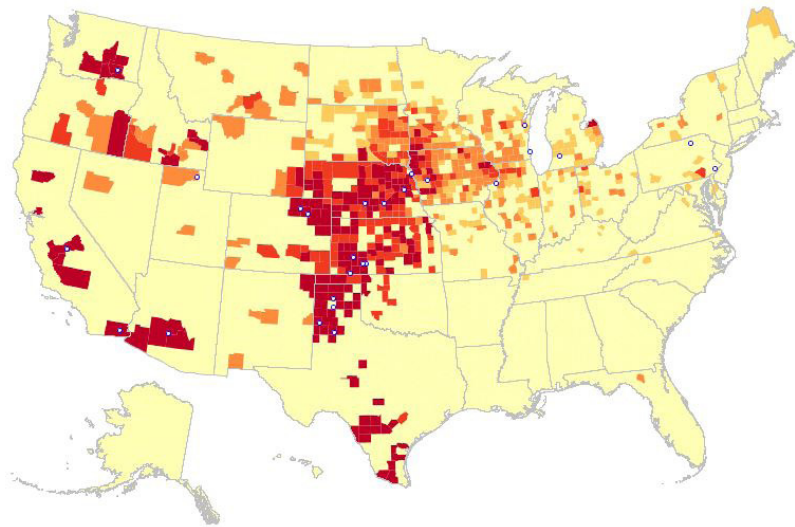
Filters

Animals Shown

- ☐ All
- ☒ Cattle
- ☐ Dairy
- ☐ Hogs
- ☐ Broilers
- ☐ Layers

Census Year

- 1997
- 2002
- 2007
- ☒ 2012



Source: Food & Water Watch analysis of U.S. Department of Agriculture Census of Agriculture data.

Map Key

Density Level

None	Moderate	High	Severe	Extreme
------	----------	------	--------	---------

Meat Plants

The United States consumes mostly pork and beef as their primary red meat sources, these maps show the distribution of the farms that produce the animals we eat.

This is literally every goat in the United States.

One dot = 500 goats.



WASHINGTONPOST.COM/**WONKBLOG**

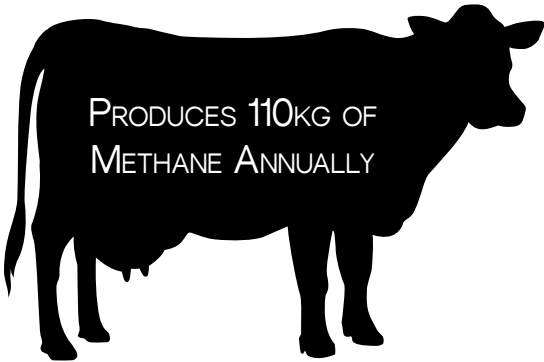
Source: USDA Agricultural Census

Despite our love of meat we do not consume the most popular meat in the world, goat. A study by Professor John M. Harper suggested that 63% of people consume goat, more than any other meat. In fact, there is so little goat meat eaten in the United States that it does not rank on any lists I've seen on percent consumption compared to any other animal.

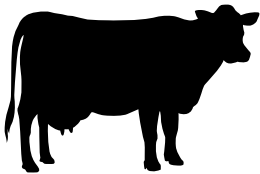
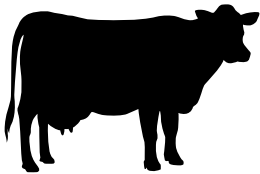
Every study suggests our aversion to goats to a constructed reality, goats seem foreign and therefore is scary.

Why is this important?

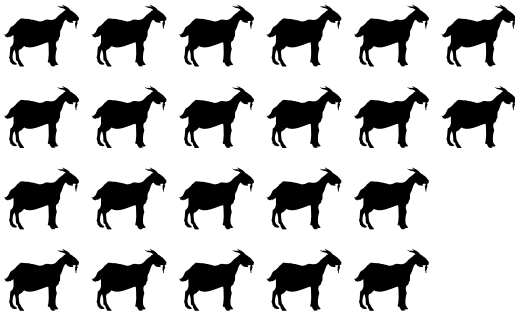
METHANE



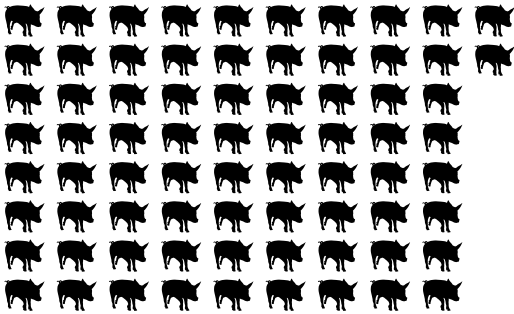
1 DAIRY COW



= 2 MEAT COWS =



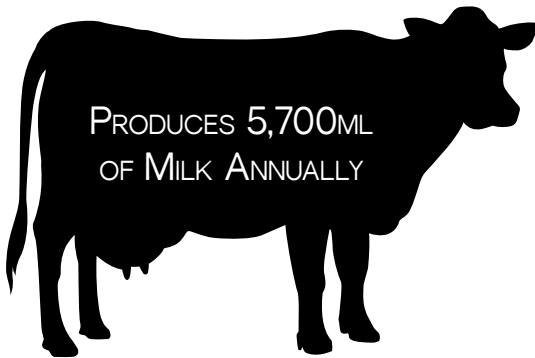
22 GOATS



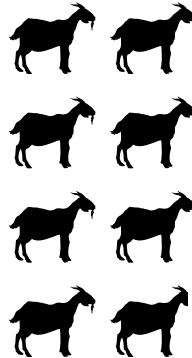
= 74 PIGS

Ecological Analysis

MILK

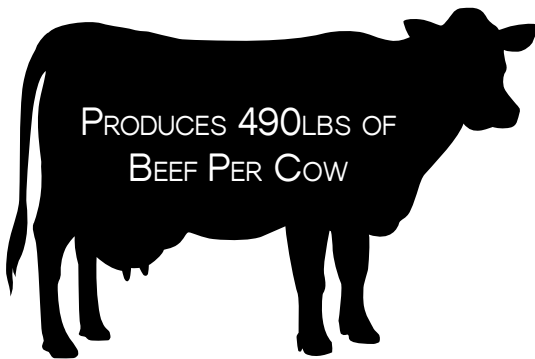


1 DAIRY COW

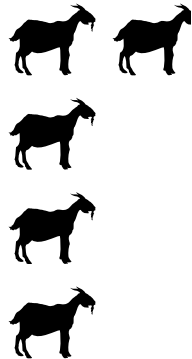


= 7.9 GOATS

MEAT



1 MEAT COW



4.1 GOATS



= 3.6 PIGS

Baa

Goat, roasted

Amount Per 3 oz (85 g)

Calories 122

Total Fat	2.6 g	4%	
Saturated fat	0.8 g	4%	
Polyunsaturated fat	0.2 g		
Monounsaturated fat	1.2 g		
Cholesterol	64 mg	21%	
Sodium	73 mg	3%	
Potassium	44 mg	9%	
Total Carbohydrate	0 g	0%	
Dietary fiber	0 g	0%	
Sugar	0 g		
Protein	23 g	46%	
Vitamin A	0%	Vitamin C	0%
Calcium	1%	Iron	17%
Vitamin D	0%	Vitamin B-6	0%
Vitamin B-12	16%	Magnesium	0%

Moo

T-bone steak, broiled

Amount Per 3 oz (85 g)

Calories 210

Total Fat	14 g	21%	
Saturated fat	5 g	25%	
Polyunsaturated fat	0.5 g		
Monounsaturated fat	6 g		
Cholesterol	51 mg	17%	
Sodium	57 mg	2%	
Potassium	257 mg	7%	
Total Carbohydrate	0 g	0%	
Dietary fiber	0 g	0%	
Sugar	0 g		
Protein	21 g	42%	
Vitamin A	0%	Vitamin C	0%
Calcium	0%	Iron	15%
Vitamin D	0%	Vitamin B-6	15%
Vitamin B-12	31%	Magnesium	5%

Nutritional Analysis

Bloop

Tilapia, cooked

Amount Per 1 fillet (87 g)

Calories 112

Total Fat	2.3 g	3%
Saturated fat	0.8 g	4%
Polyunsaturated fat	0.5 g	
Monounsaturated fat	0.8 g	
Cholesterol	50 mg	16%
Sodium	49 mg	2%
Potassium	331 mg	9%
Total Carbohydrate	0 g	0%
Dietary fiber	0 g	0%
Sugar	0 g	
Protein	23 g	46%

Vitamin A	0%	Vitamin C	0%
Calcium	1%	Iron	3%
Vitamin D	32%	Vitamin B-6	5%
Vitamin B-12	26%	Magnesium	7%

Oink

Pork, loin, whole, broiled

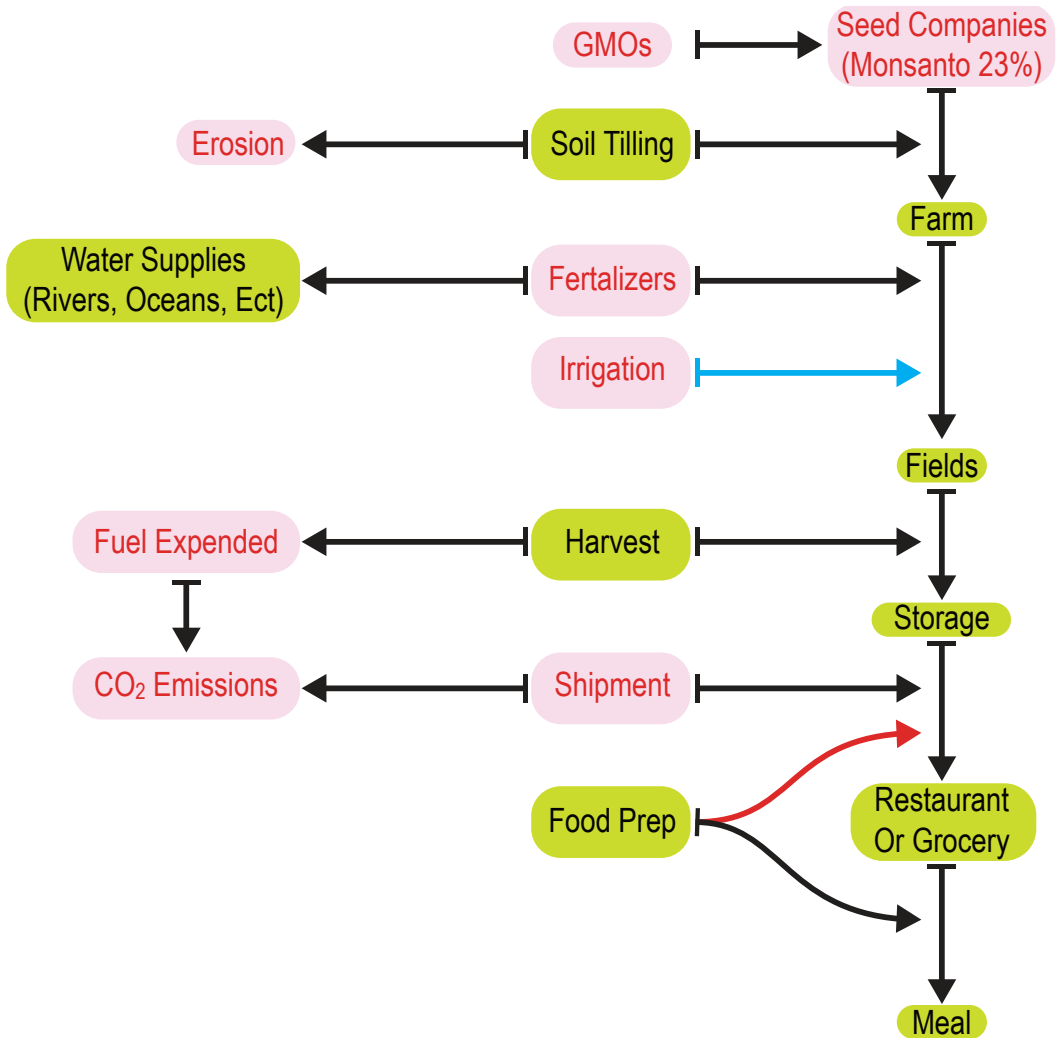
Amount Per 3 oz (85 g)

Calories 206

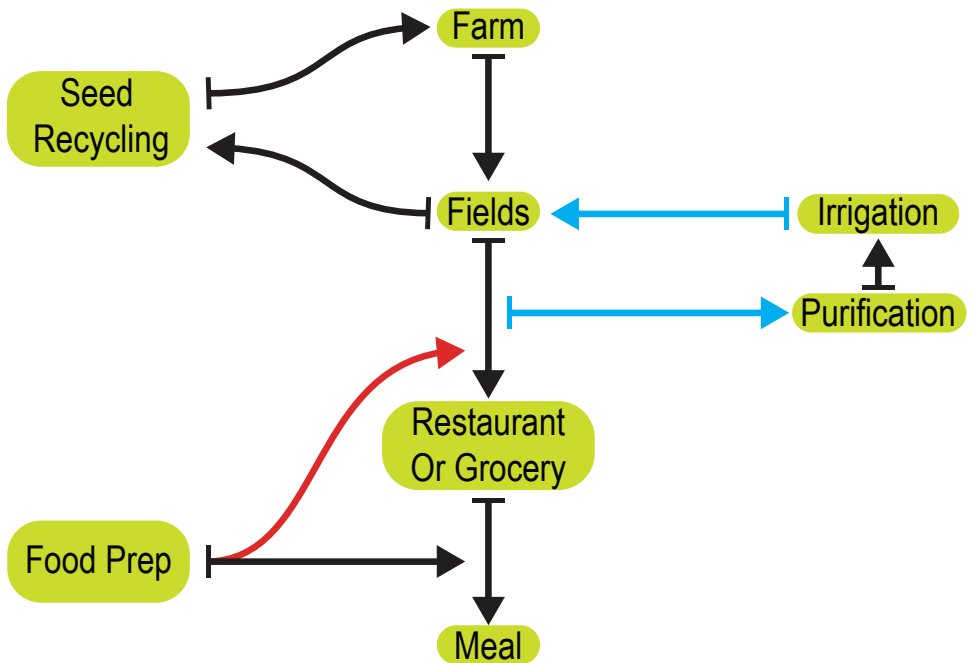
Total Fat	12 g	18%
Saturated fat	4.4 g	22%
Polyunsaturated fat	1 g	
Monounsaturated fat	5 g	
Cholesterol	68 mg	22%
Sodium	53 mg	2%
Potassium	360 mg	10%
Total Carbohydrate	0 g	0%
Dietary fiber	0 g	0%
Sugar	0 g	
Protein	23 g	46%

Vitamin A	0%	Vitamin C	0%
Calcium	1%	Iron	3%
Vitamin D	11%	Vitamin B-6	20%
Vitamin B-12	10%	Magnesium	6%

How We Farm



How We Could Farm



1/2

Data on Farming

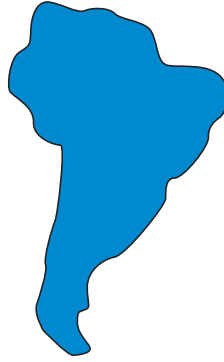
Currently in the United States it is estimated that 50% of the food we grow (for the purpose of Food) does not reach the plate of a consumer. The reasons vary from drought, flood, spoilage, and disease; all factors eliminated if farming is moved indoors.

PRESENT



6.8 Billion People

=

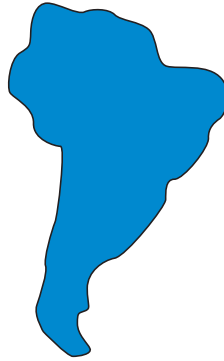


2050



9.5 Billion People

=



+

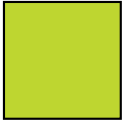


“We now farm a landmass the size of South America, which does not include grazing land.”

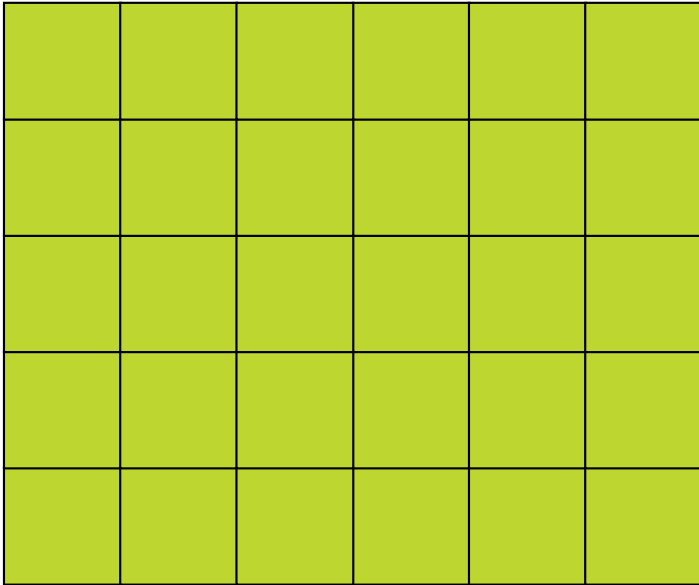
The Vertical Farm - Dr. Dickson Despommier

“[By 2050,] If we continue to farm in the traditional fashion, then we would need another Brazil's worth of land to farm to produce crops.”

The Vertical Farm - Dr. Dickson Despommier

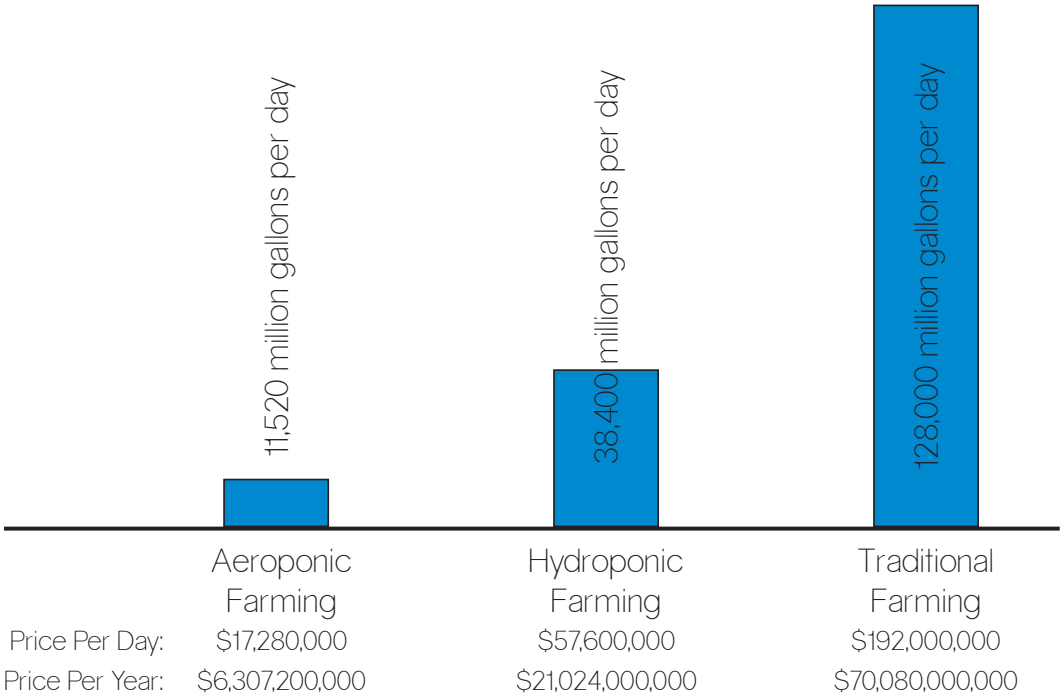


Vertical Farming
Land Use



Traditional Farming
Land Use

Through understanding of our diets Jason Bradford Ph.D. estimates a person requires about one acre of land to feed them for a year. 34.5 percent of a person's diet is made of fish and vegetables. It requires 15028 ft² to feed a person their fruits and vegetables with 25 percent of that as aquaponics to fill the demand for fish (Tilapia, Trout, Carp, Catfish, and Largemouth Bass). With hydro and aeroponic one acre of land grows enough for 30 people to live off in a year, this means each person requires 500 ft² of aero and hydroponics.



Despommier states “Some 70 percent of all available freshwater on earth is used for irrigation.” With Urban Vertical Farming the use of hydroponic and aeroponic farming methods could save millions of dollars and trillions of gallons in water a year. Hydroponic farming uses approximately 70 percent of the water in traditional farming. Aeroponic farming uses approximately 70 percent of the water in hydroponic farming.

Under the chart are the numbers for those who need to understand the detriment on the environment in “natural capital” rather than basic environmental understanding.

Additionally, any water that emerged from the vertical farm would be drinkable



Photography by Michael Gunther

What is the Effect?

“[From the beginning of evolution] Symbiosis became the norm and now defines all of nature”

The Vertical Farm - Dr. Dickson Despommier



Photo: courtesy of South River Federation

Agricultural runoff is responsible for more ecosystem disruption than any other kind of pollution. This is why the United States must import more than 80 percent of its seafood from abroad. If this trend continues, the ocean's crustaceans, mollusks, and coral reefs will be in big trouble, since calcium carbonate, a major component of their shells and matrix, cannot form at pH values much below 8.0. The pH value of the ocean is now at 8.06; just twenty-five years ago it was 8.16.



1. Build



2. Replace



3. Rebuild

Once Vertical farms are built they will start to replace the cropland. The question is; what happens next? This question is answered through looking at what happened during the dust bowl and cotton plantations in this country. Both produced major crop yield however once the industry dried up we often let the land go free not trying to fix it at all; in doing so we helped the land more than we could have done if we tried. The land grew back to its natural state.

Nature abhors a vacuum.

“Only those with no memory insist on their originality.”

- Coco Chanel

Chapter 2 | Precedent

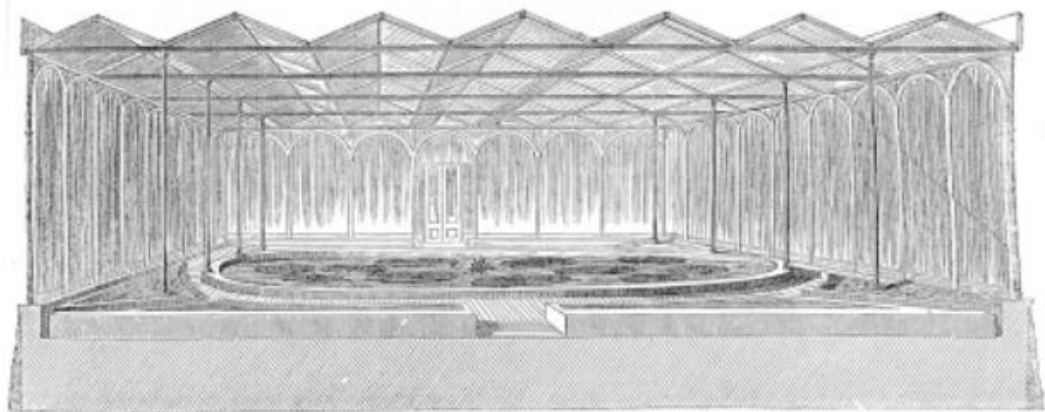


Photo: courtesy of Gardeners Chronicle

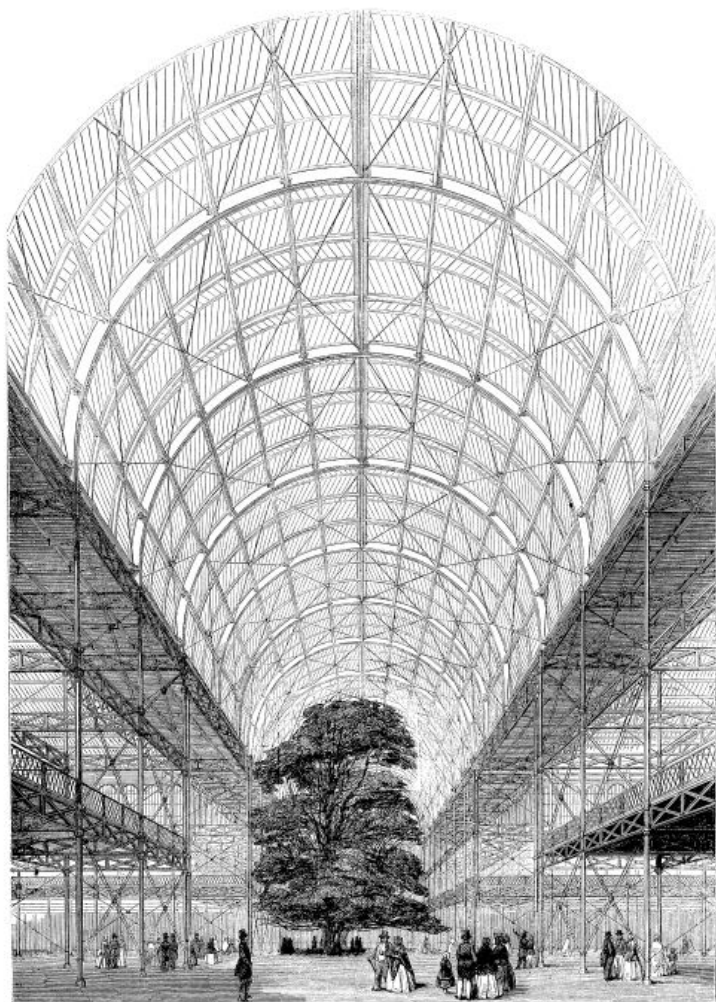
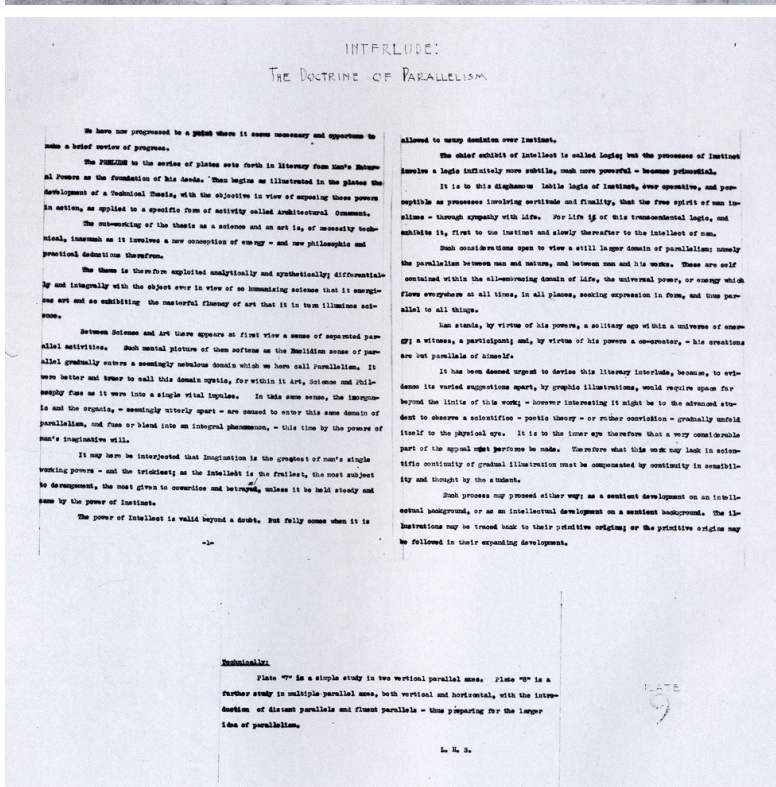
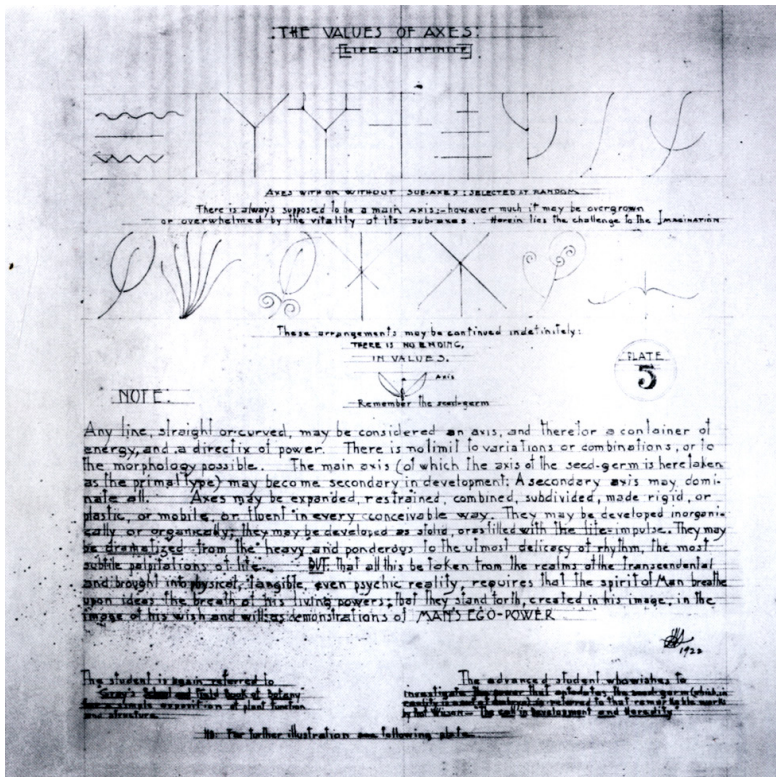


Photo: courtesy of Colgate University Library

Joseph Paxton

In 1832, Paxton developed an interest in greenhouses at Chatsworth where he designed a series of buildings with “forcing frames” for espalier trees. After much experimentation, he designed a glass house with a ridge and furrowed roof that would be at right angles to the morning and evening sun and a frame design that would admit maximum lighting. This is the forerunner of the modern greenhouse. It is within one of these greenhouses that he becomes the first man in England to bring an Amazonian water lily to flower in November 1849, this is done through the ability to control the climate in a building for a plant in the same way we control climates for people within buildings.

Paxton’s masterpiece, The Crystal Palace of the Great Exhibition of 1851, employed techniques taking advantage of technological advances in the manufacture of both glass and cast iron. The pavilion created an interior garden space which used sunlight to control temperature and housed both plants and animals alike. The multi-story building combined this indoor garden with gallery and community space creating a very popular space that promoted culture.



Louis Sullivan | The Seed

Sullivan explores the complex creations of nature through an understanding of the line and its manifestation in the natural environment. This portion of his paper he dubs as Remember The Seed-Germ relating all ingenuity to original manifestations in nature that are then adapted by people. He argues, through drawings, the many different forms seeded in nature.



Photos: courtesy of Kono Designs

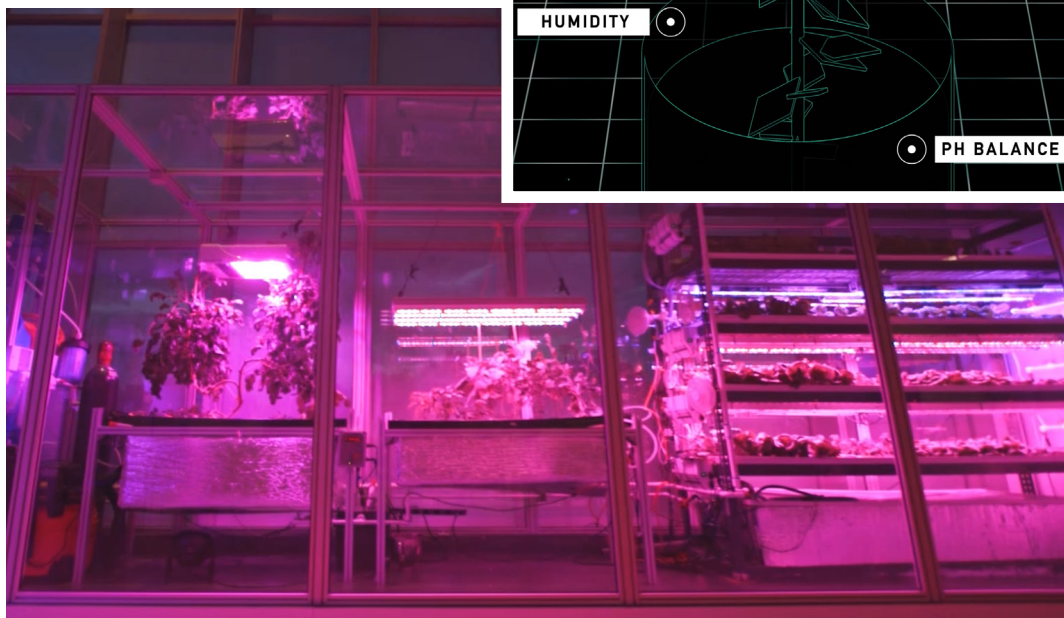
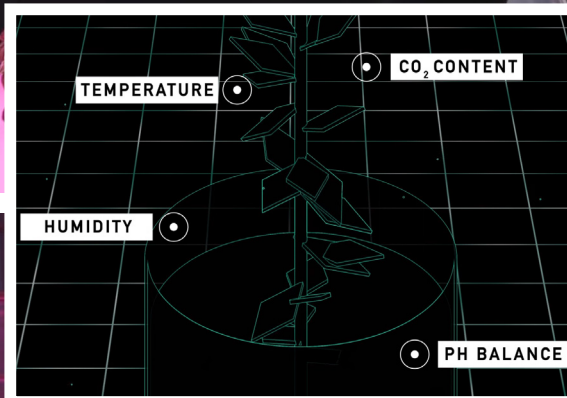
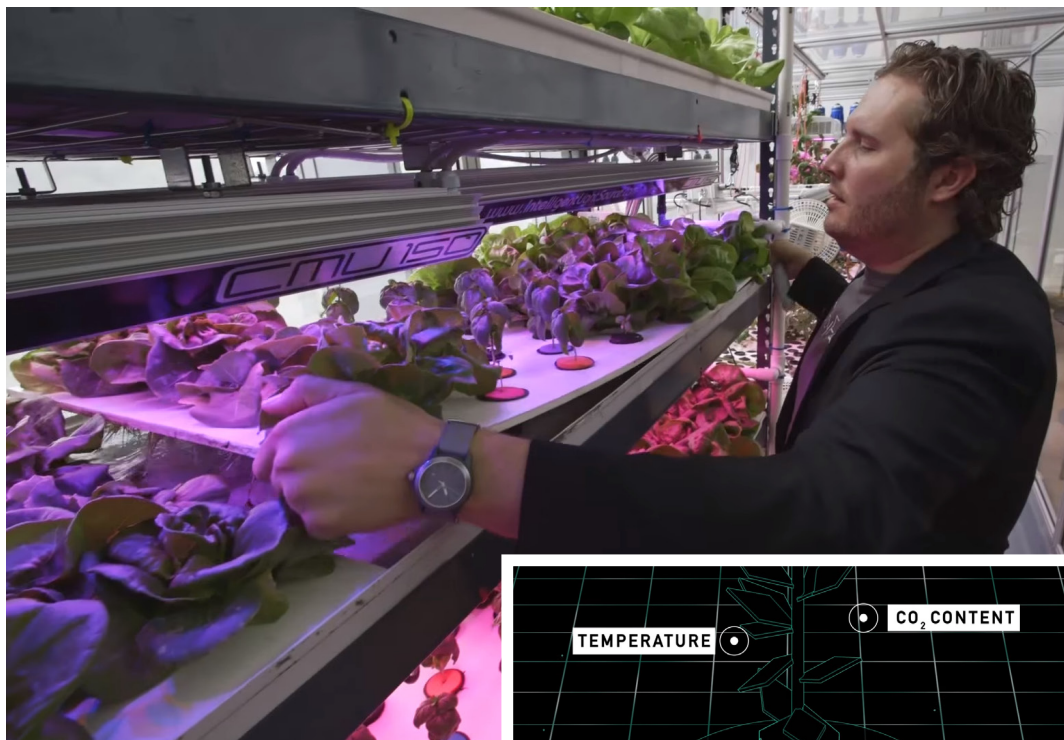
OTEMACHI HQ - Kono Designs

Otemachi HQ (Tokyo) is a 10,000 sq ft space of over-ground farmland located in Otemachi Headquarters building. It showcases city farming initiative. The company took over a 50-year-old structure and renovated it into the urban farm. O2 elected to dedicate considerable space inside the building to hydroponic and soil-based farming, which is interspersed throughout the entire building. There are a total of 100 different types of produce grown. Through their urban farm and headquarters, the recruitment company is also supporting the education of Japan's next generation of farmers who work in internships to learn about food production.

“It is the largest and most direct farm-to-table of its kind ever realized inside a building in Japan,”

-Kono Designs

The combination of education with urban farming is key due to most people's lack of connection with their food and the world's steady decline of farmers. There are natural needs and market needs, for a long time market needs have outweighed natural needs yet we must remember, everyone must eat.



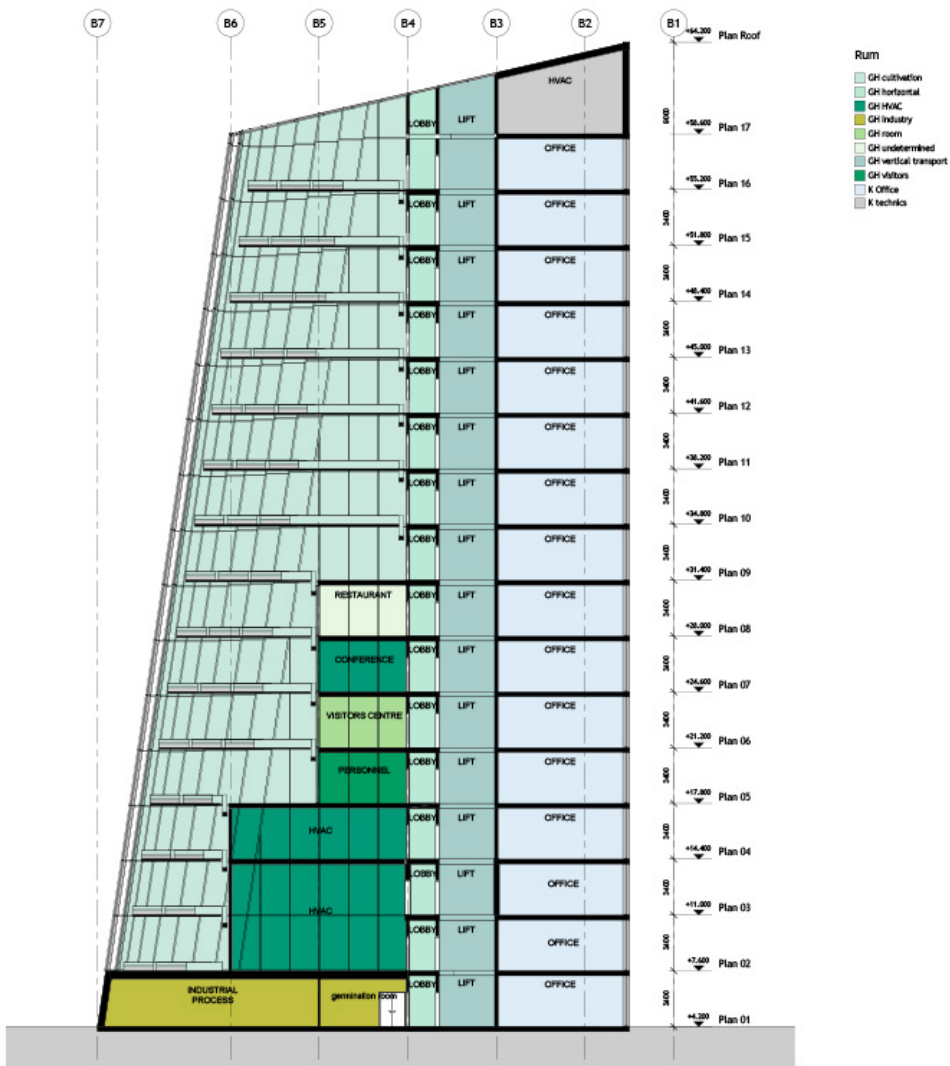
Photos: courtesy of Detours: Season 2, Episode 1 YouTube

MIT | City Farm

At the MIT Media Lab Open Agriculture (“OpenAG”) Initiative they are on a mission to bring out the farmer in “city folk” by creating healthier, more engaging, and more inventive food systems. OpenAG is building collaborative tools and platforms to develop an open-source ecosystem of food technologies that enables and promotes transparency, networked experimentation, education, and local production.

The OpenAG process begins with the production of controlled environment agriculture systems. These “food computers” are set to create specific internal climates that can be modified, manipulated, upgraded, and hacked as users experiment to find the perfect climate recipes for their favorite fresh foods. Users from diverse backgrounds will innovate and optimize in unique ways as they find solutions to each challenge they face. Nutrition and flavor can be maximized, water and energy use can be minimized, and preferences can be customized to suit every individual set of needs. OpenAG intend for people to cut out the distance and import climates rather than food. Breaking down geographical limitations and cutting down on transportability requirements will allow local growers to focus on feeding people in their own communities. This is the exact technology that can be used to boost availability of culturally specific food in distant places, a comfort especially to people displaced due to wars and rebellion such as the Somali, Hmong and Vietnamese populations in Minneapolis

In building this open network, OpenAG will also create communities in which the smallest scale climate can instantly be translated to make the largest impact. When shared openly, controlled environment agriculture will provide access to fresh, nutritious, and delicious foods, grown locally, anywhere on Earth.



Photos: courtesy of Plantagon
2 | Precedent | Plantagon

Plantagon

“Plantagon International is the global innovation leader in the sector urban agriculture. Plantagon’s resilient food systems minimize the need for land, water, energy and pesticides. The environmental impact is very low, and if the products are delivered directly to consumers in the city, the transportation costs are also minimized.

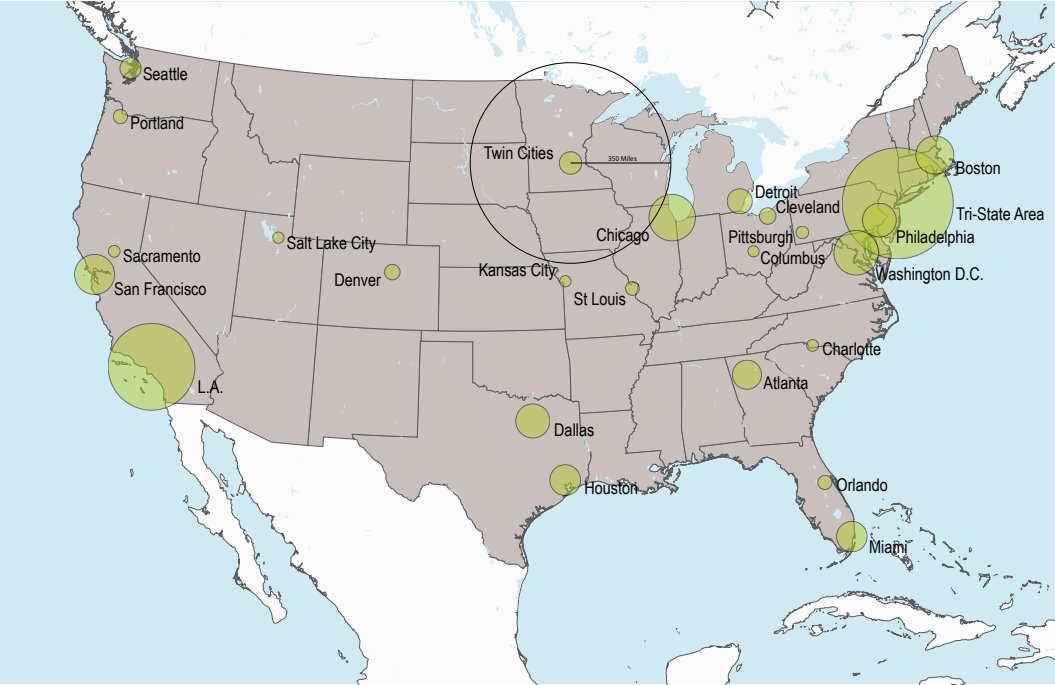
[Plantagon] develops innovative solutions to meet the rising demand for locally grown food in cities all around the world. [They] minimize the use of transportation, land, energy and water – using waste products in the process but leaving no waste behind.”

-Plantagon, About Us

The ideas behind Plantagon which aims to create a large scale indoor Vertical Farm relate very closely to the ideas of Joseph Paxton with the use of greenhouse technology to spur growth. The Seed will act differently, incorporating the linkage of smaller micro climates that utilized natural and mechanical control systems to create ideal growing climates. Imagine the model of MIT’s City Farm, linked like a battery in both series and parallel.

Nothing endures but change. – Heraclitus

Chapter 3 | Method



City | Site

Minneapolis | St. Paul | MN

Pop. 3,459,146 (16th)

Urban: 1,022 Square Miles

Metro: 8,120 Square Miles

2nd largest economy in the Midwest

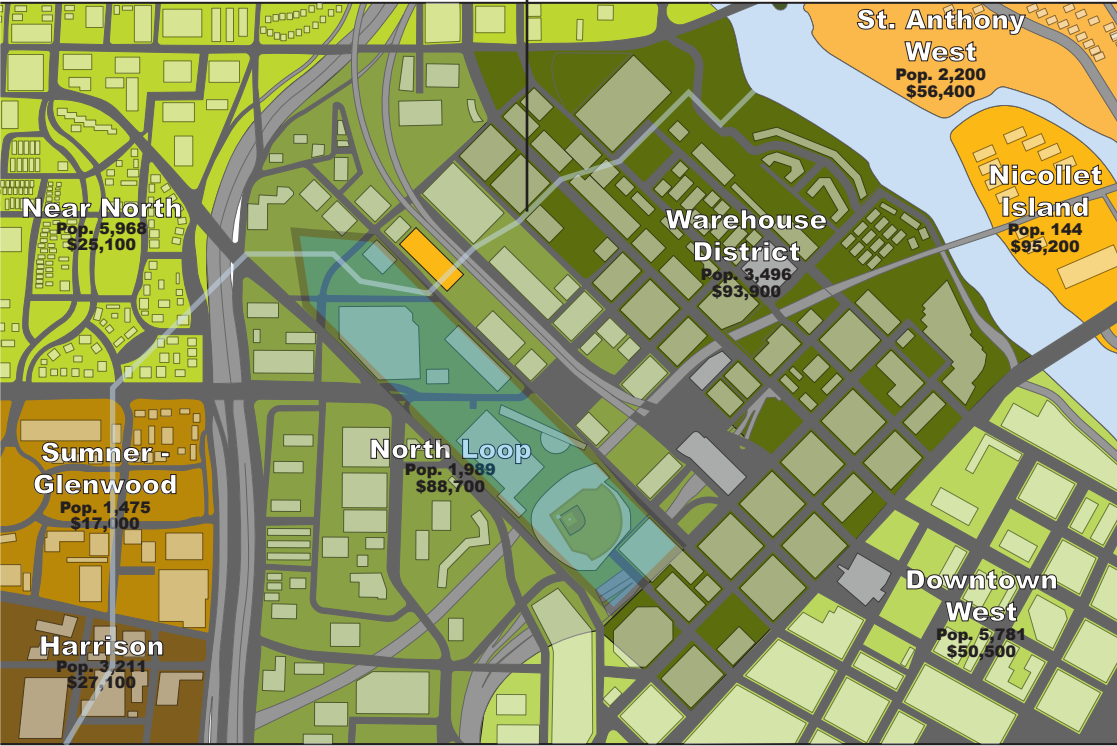
Yet, 10.6% of households are food insecure

In 1950, MN was the 15th in vegetable production

We are currently 6th in farm production

Yet now 85% - 90% of food is imported to MN

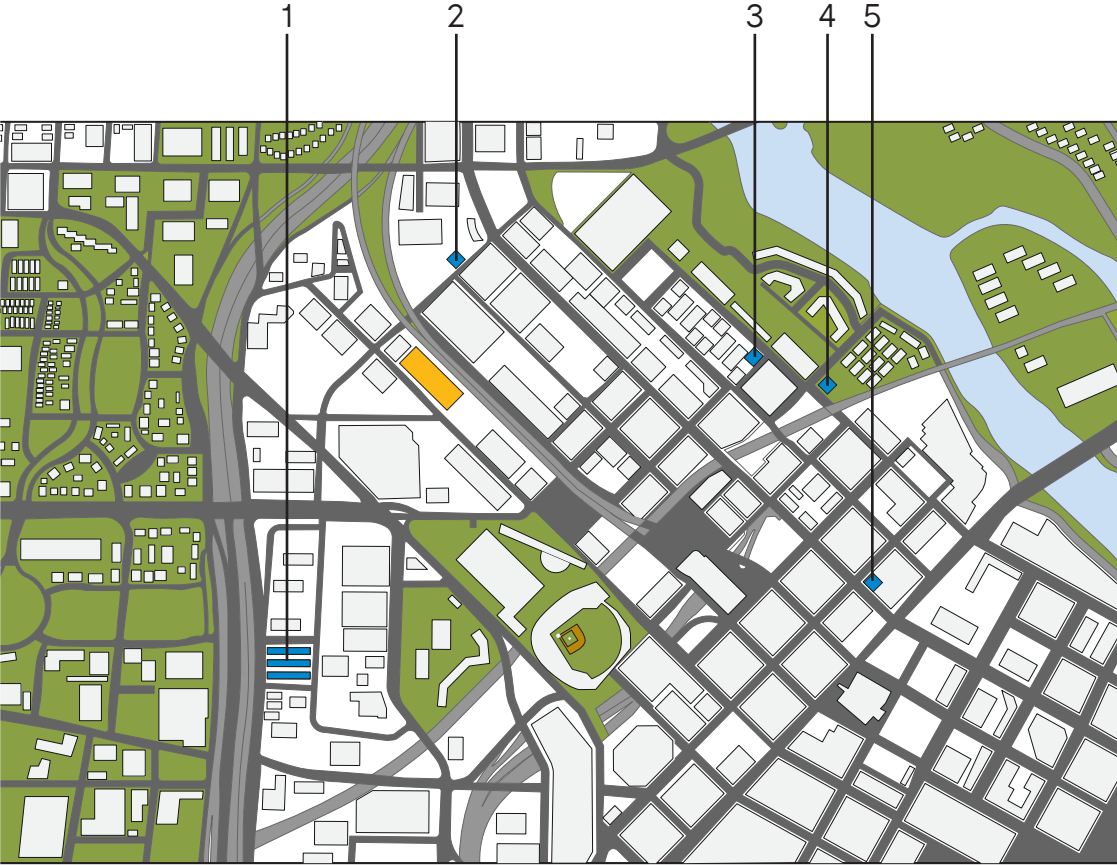
Bassett Creek



The Site

Located in the quickly growing North Loop adjacent to the Warehouse District and not far east from The Northside, a neighborhood historically underserved. The site is located over the buried Bassett Creek a small tributary leading to the Mississippi River. This creek acts as a storm water drain for much of the area, collecting the drainage from streets, highways and freeways. This is a perfect opportunity to plug in to the system with The Seed and watch it convert this grey water into clean water through a public garden area with humidity collectors.

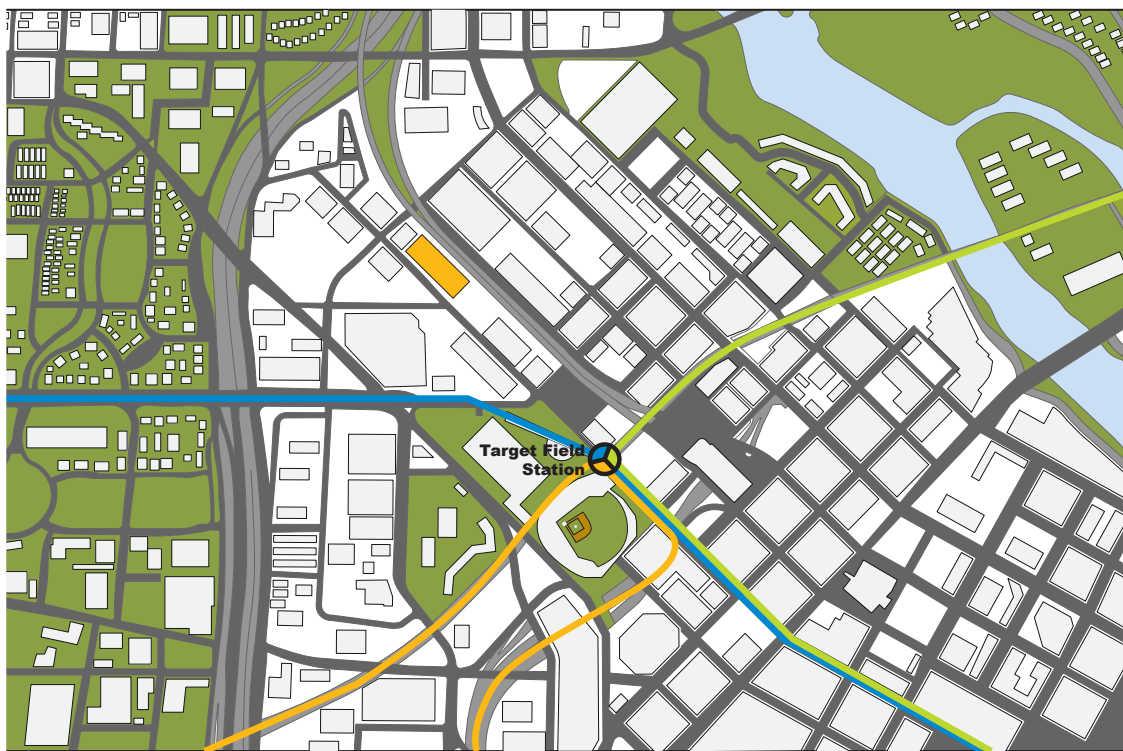
The corridor leading from Downtown West past Target Field toward Near North (highlighted in blue) is under rapid development and is quickly growing in density and vertical height. A majority of the buildings are housing but there is a distinct lack of food sources other than the weekly farmers market



Food Access

As stated previously, there is a large amount of housing going into the area yet there is a distinct lack of food sources other than the weekly farmers market (located at 1).

1. The Farmer's Market
Occurs Once a Week, Seasonal Selections
2. Zuccaro's Produce
"Corner Store", Small Selection, Limited Hours
3. Runds Market
Convenience Store, Mostly Processed Food
4. Local D'Lish
Restaurant/Grocer, Boutique Items & Prices
5. Whole Foods Market
Green Washed, Expensive, Good Selection



Transit

The Twin Cities have been growing their light rail services since the early 2000s and Target Field (Home of the MN Twins) is a major hub for this light rail system with the three completed lines intersecting here.

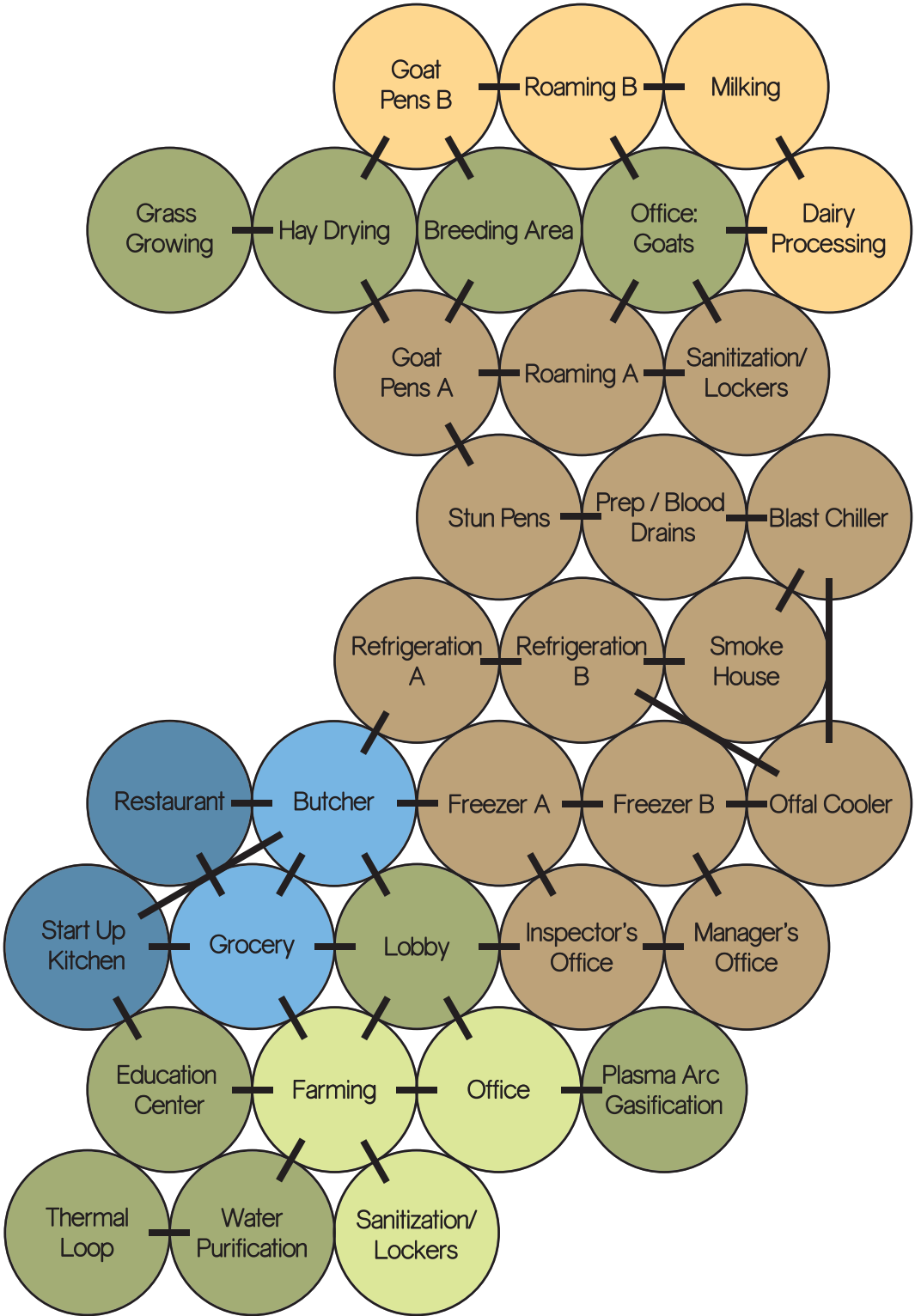
This not only creates convenience of shoppers to arrive at the grocery but also can be tapped into as a source of distribution of the product produced in the farm.



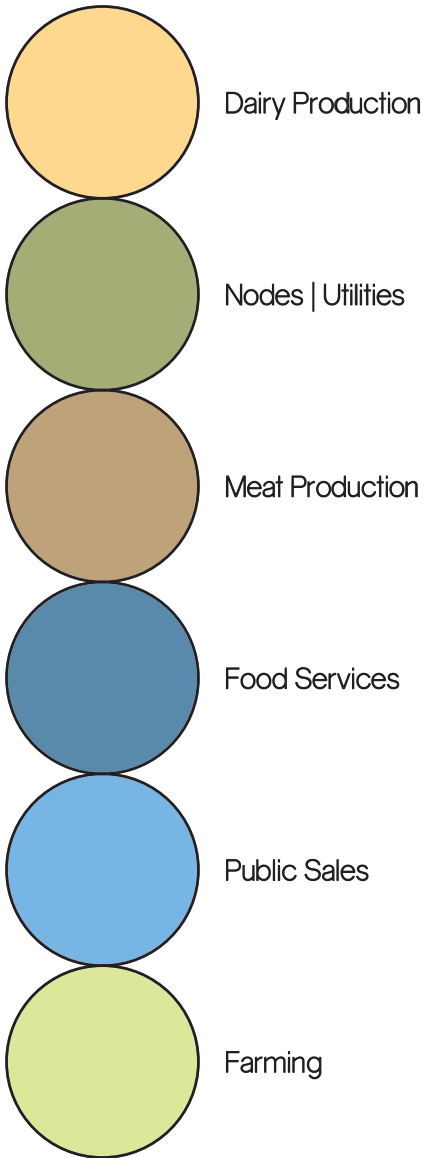
Growth

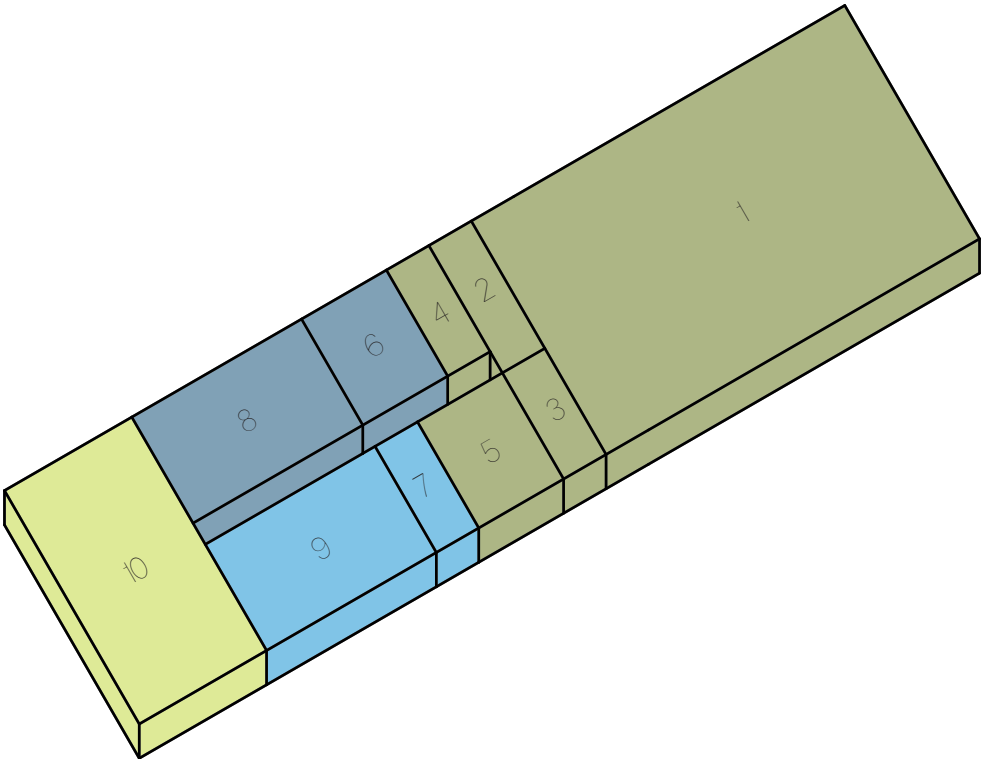
Adjacent to the North Loop is the Warehouse District a part of town that has grown by 1100% in the past 15 years. The area however only has small convenience stores and no groceries.

Additionally the lot across the street from the vertical farm is about to be developed into a 79 unit housing for recently unincarcerated men looking to rebuild their lives with their families. This is another 4% increase to the population, straining an already poorly supported food system.



Vertical Farm Program Relations

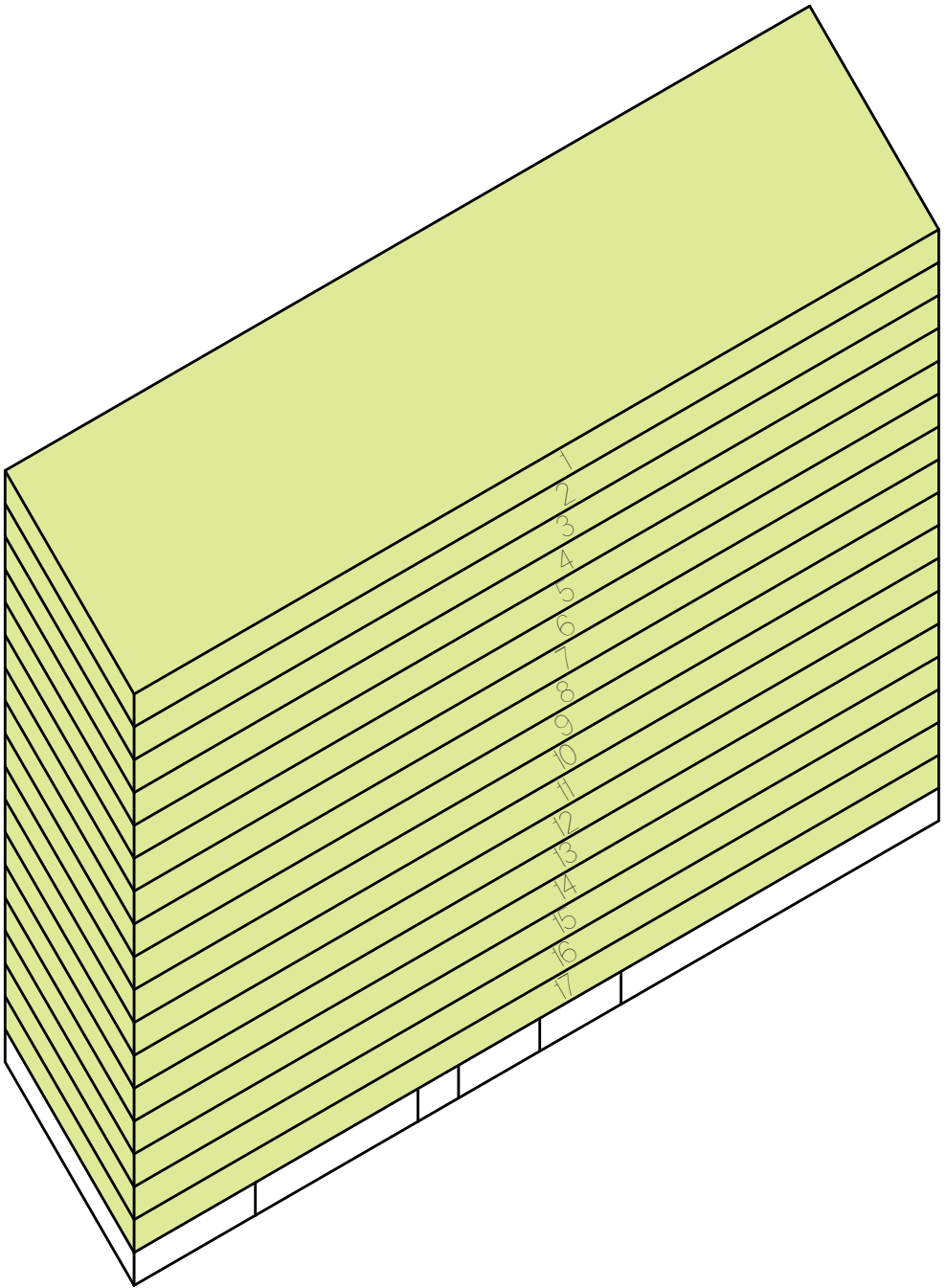




The Ground Floor of The Vertical Farm is comprised of public spaces encouraging interaction with food and farming.

Break Down:

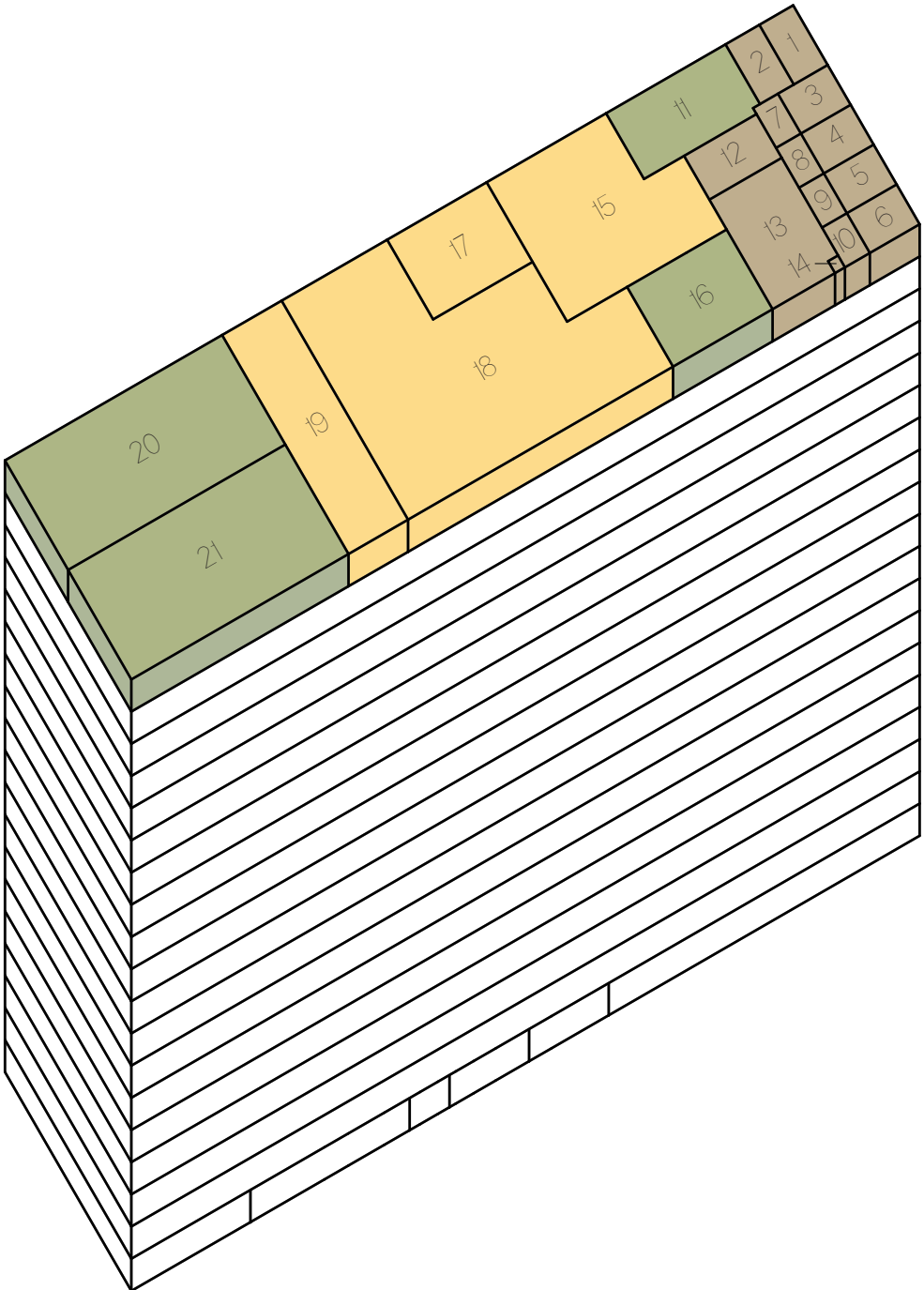
1.	Public Indoor Garden	(17,160 SQFT)
2.	Utilities	(1,200 SQFT)
3.	Lobby	(1,000 SQFT)
4.	Lobby 2	(1,000 SQFT)
5.	Education	(2,000 SQFT)
6.	Start-Up Kitchen	(2,000 SQFT)
7.	Butcher	(1,000 SQFT)
8.	Restaurant	(4,000 SQFT)
9.	Grocery	(4,000 SQFT)
10.	UMN USDA Offices	(6,500 SQFT)



The bulk of the Vertical Farm is dedicated to farming itself. Each acre of a traditional farm can feed a person for a year (this includes grazing land) 34.5% of an average American's diet is fruit and vegetables this means 15028 ft² is required to feed the average person. A vertical farm uses methods that supply 30x that of a traditional farm. Traditional farming additionally only gets one harvest a year, Vertical Farming can get 6 - 8 harvests a year. With this breakdown means 83.488 ft² is required to feed a person for a year. With 17 Acres of double stacked Hydro/Aero-ponic farming the Seed can feed 17772 people. This would provide enough food for The Warehouse District, The North Loop, Near North, Sumner/Glenwood and Harrison Neighborhoods.

Break Down:

1-17. Farming (740,520 SQFT)



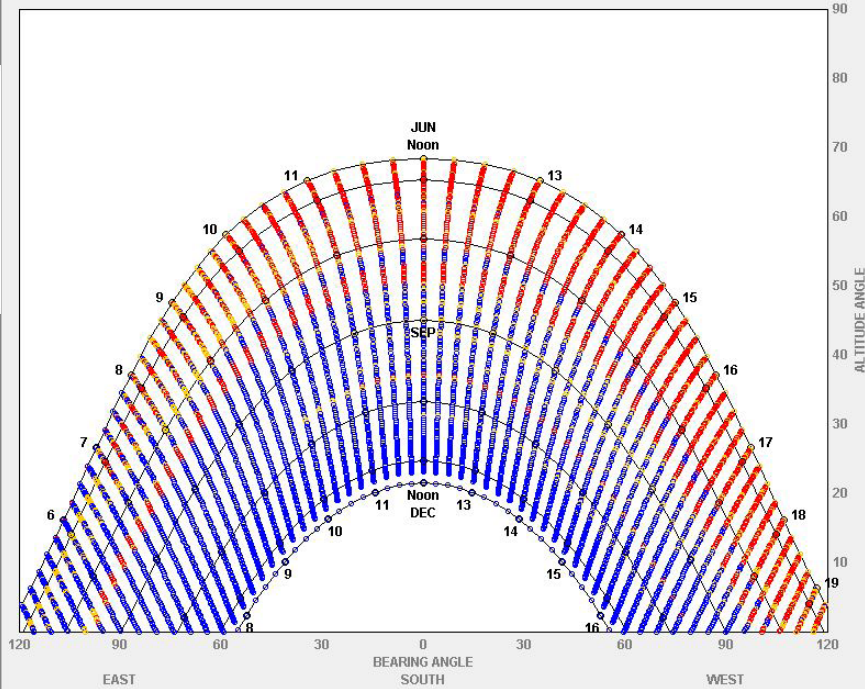
The production of meat and dairy from goats is a complex process involving many steps these are laid out through a specific organizational strategy

Break Down:

1.	Inspector's/Manager's Offices	(500 SQFT)
3.	Offal Cooler	(500 SQFT)
4.	Freezer A	(500 SQFT)
5.	Refrigeration A	(500 SQFT)
6.	Blast Chiller	(500 SQFT)
7.	Smoke House	(250 SQFT)
8.	Freezer B	(250 SQFT)
9.	Refrigeration B	(250 SQFT)
10.	Prep, Blood Draining	(250 SQFT)
11.	Office	(2,000 SQFT)
12.	Goat Pens (52 males)	(780 SQFT)
13.	Roaming A	(2,000 SQFT)
14.	Stun Pens	(30 SQFT)
15.	Dairy Processing	(5,000 SQFT)
16.	Breeding Area	(2,000 SQFT)
17.	Milking	(2,000 SQFT)
18.	Roaming B	(10,500 SQFT)
19.	Goat Pens (150 Females)	(2,250 SQFT)
20.	Grass Growth	(6,000 SQFT)
21.	Hay Drying/ Bailing	(6,000 SQFT)

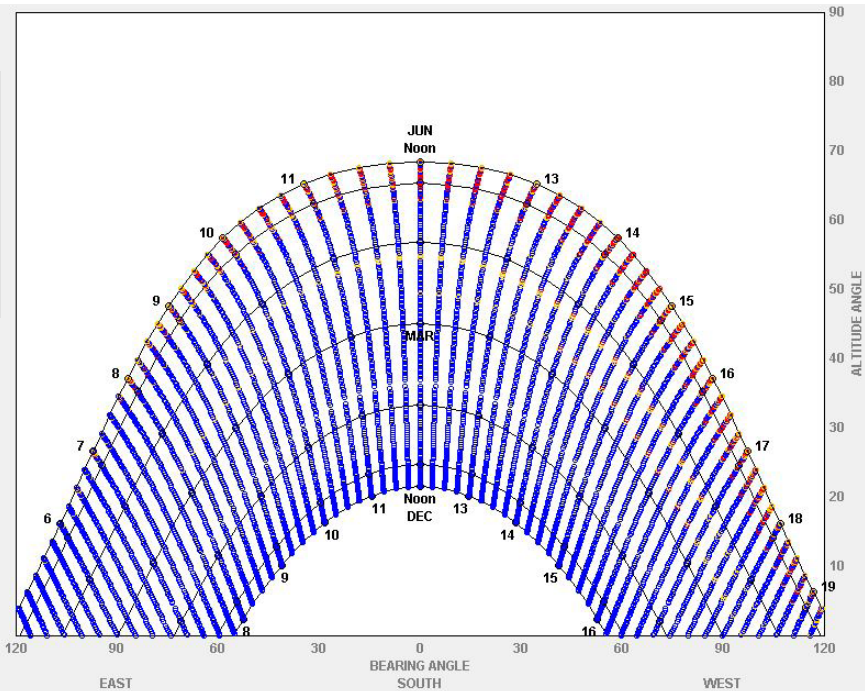
Summer - Fall
Sun Shading

- **WARMHOT > 75°F**
(SHADE NEEDED)
772 Hours Exposed
0 Hours Shaded
- **COMFORT > 68°F**
(SHADE HELPS)
391 Hours Exposed
0 Hours Shaded
- **COOL/COLD < 68°F**
(SUN NEEDED)
1435 Hours Exposed
0 Hours Shaded



Winter - Spring
Sun Shading

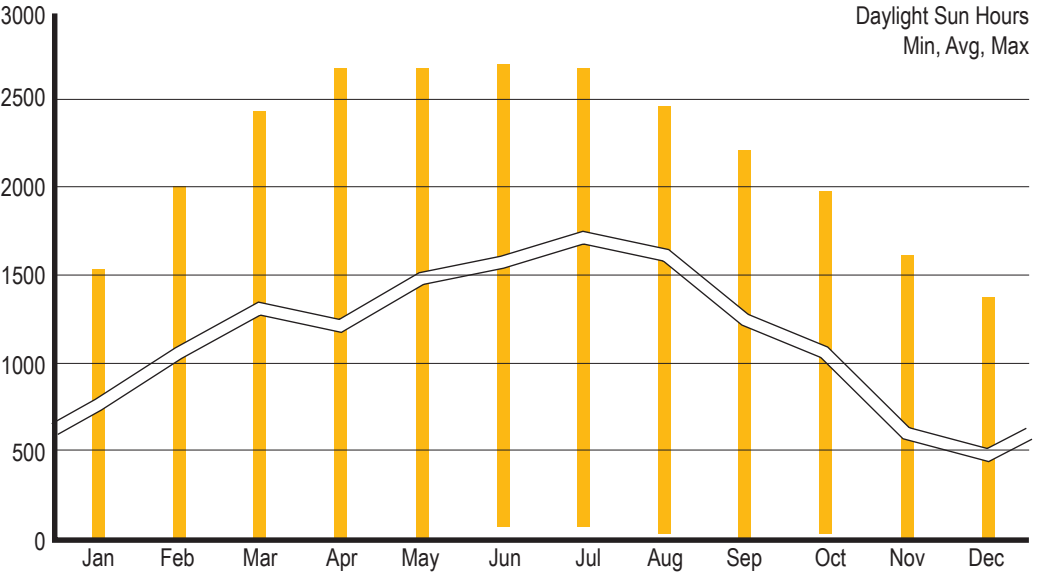
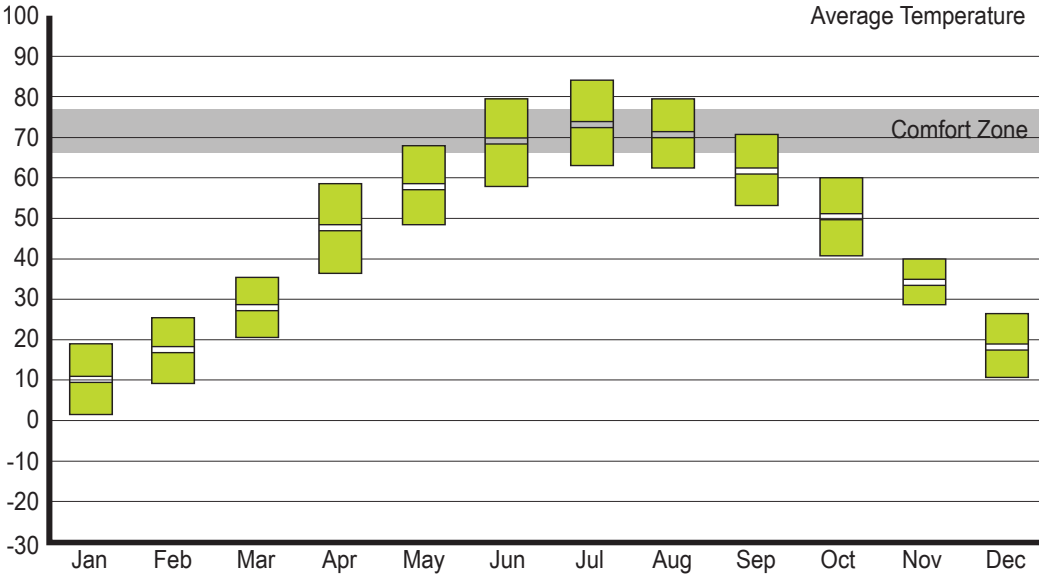
- **WARMHOT > 75°F**
(SHADE NEEDED)
268 Hours Exposed
0 Hours Shaded
- **COMFORT > 68°F**
(SHADE HELPS)
186 Hours Exposed
0 Hours Shaded
- **COOL/COLD < 68°F**
(SUN NEEDED)
2054 Hours Exposed
0 Hours Shaded



Environmental Analysis

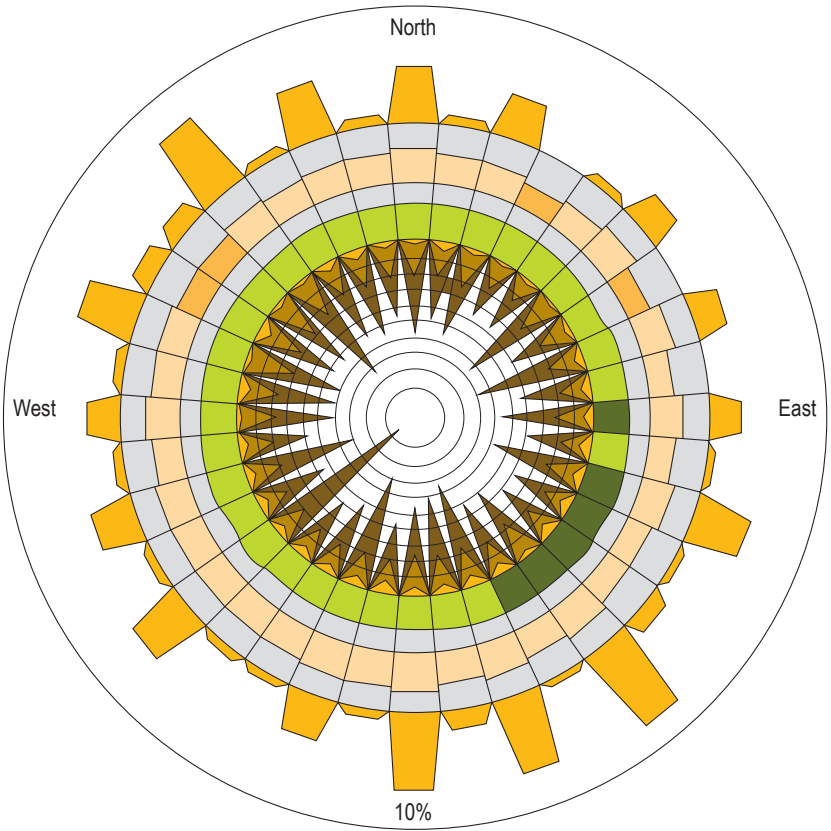
Sun shading is very important to a project about vertical farming due to the fact that plants need to use the sun as sources of food. The energy collected by solar panels will also have an important effect on the power that the building uses to create responsible food sources.

These graphs show the Summer and Fall to have a large amount of sun light however in the Winter and Spring there is very little sunlight due to high amounts of shading. They also show angles of the sun and their relevant temperature ranges and where over heating occurs that requires solar shading, suggesting more horizontal shading in the south at certain degrees. This solar shading can incorporate photovoltaics to minimize building energy use

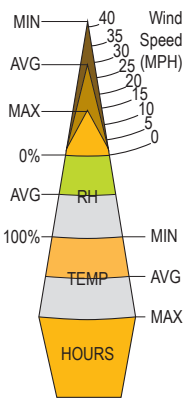


In addition to the creation of energy, the surrounding environment can help with temperature and lighting controls within the building. Parts of the building can utilize natural ventilation to heat and cool it while other parts utilize heating and air conditioning to create other environments for off season productions.

The average temperature is mostly below a human comfort zone however it is within a normal range for plant growth for seven months out of the year.

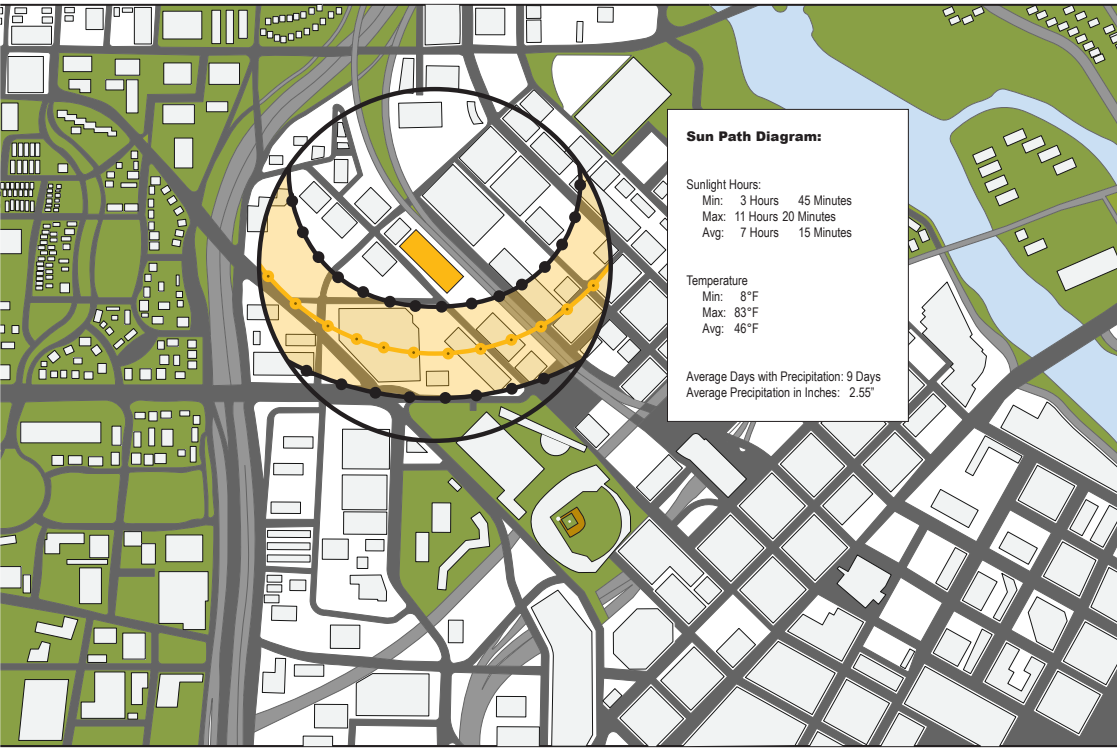


- Temperature (Deg F.)
- <32
 - 32 - 68
 - 68 - 75
 - 75 - 100
 - >100
- Relative Humidity (%)
- <30
 - 30 - 70
 - >70

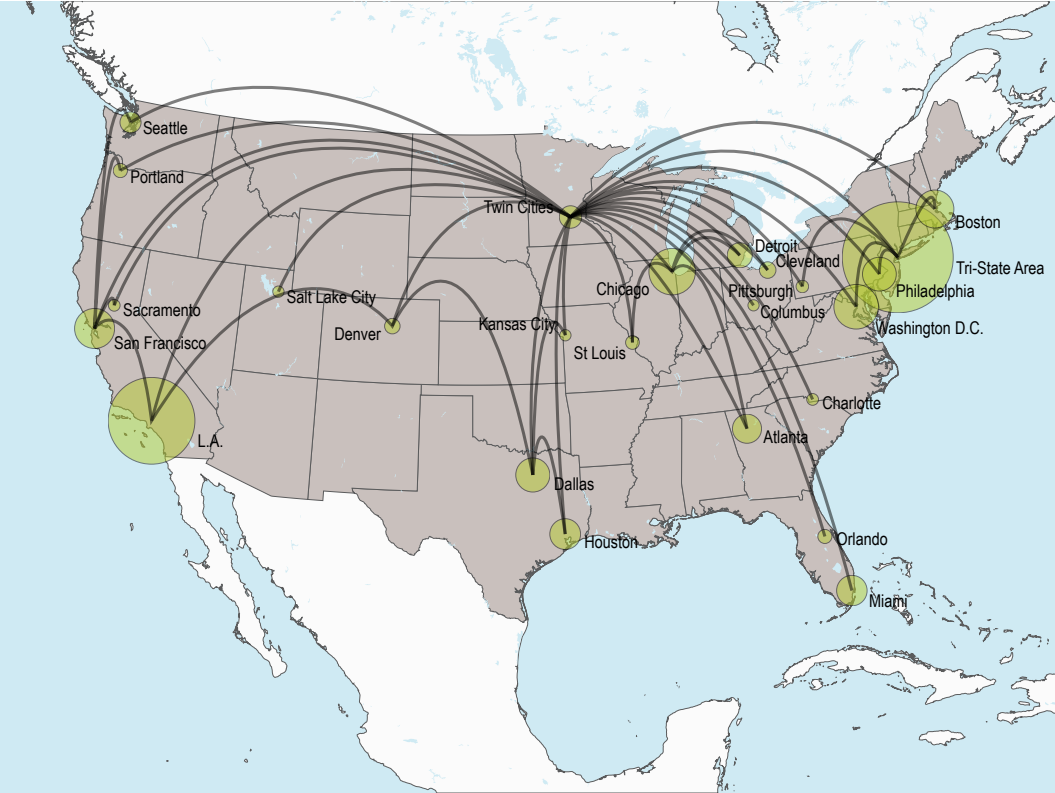


Wind direction creates a base to analyze the possibility of wind energy as well as temperature regulation through cross ventilation.

The wind wheel shows a majority of wind coming from the South-West. The majority of the rain however comes from the South-East.



Sun path analysis gives a good understanding of most and least effective times of the day and season for gathering sun. The minimum and maximum sun hours range from 3 hours 45 minutes to 11 hours and 20 minutes. This range means during the summer if energy is being collected it will be sold back to the city and then using the revenue generated The Seed will then buy back power during the winter when hours are at the lowest.



Evolution

The Seed is an act of germination, this means that if it is successful there will be more. The Seed could evolve into a network across the United States. The design would change to take advantage of natural climates but overall if a single building can produce almost 18,000 people's food in a year then the connection could grow into a large, sustainable business venture providing food security and quality across the nation.

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